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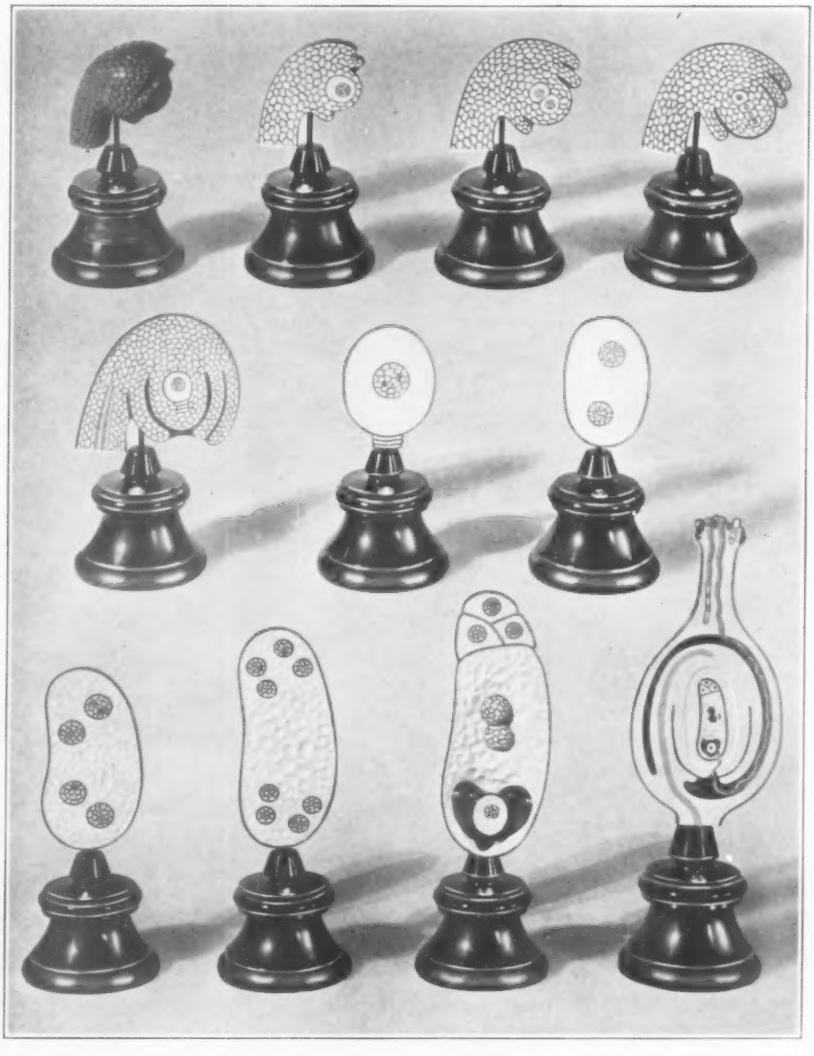

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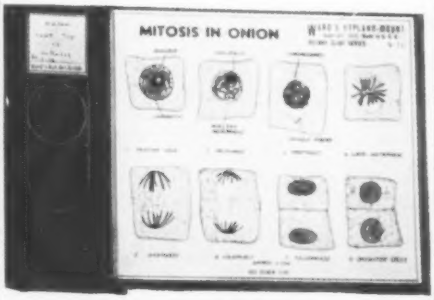

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The American Biology Teacher

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General Semantics as an Aid in Teaching the Biological Sciences for Purposes of General Education

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It is, I fear, only an intellectually-moribund teacher of biology who can be content with his work in 1940, for biologists like all other teachers of science are faced with a very perplexing question. "How," we are being asked, "does biology contribute to the 'general education' of the student?" We should not be annoyed that educators want to know what we are doing to help the student live more intelligently in the "democratic way of life." We should not even be annoyed when asked how a knowledge of the anatomy of the Coelenterata better fits a student for the business of living intelligently.

But what can one do about it? In the first place he can seriously think through what "science" is. And when he has done this he will come to the startling conclusion that when science is properly conceived, it is by its very nature fundamentally concerned with general education. What is the interpretation of science which automatically contributes to general education? It is simply the recognition that the scientist's contribution to general education is not himself, or his information, but his method of inquiry.[1] And that method of inquiry is also simple —but revolutionary. Stripped of high sounding phrases it merely implies that the scientist asks his questions of the behavior of *things*, rather than of the behavior of *words* within a *system* of verbal logic. This sounds ridiculously elemental but the implications of such a concept of the scientific-method are far reaching because it implies that the question *must be asked* in such a manner that it *can be*

[1] For a detailed statement of the "scientific-method" which includes linguistic aspects of science see: Parkinson, Charles E., *Materials Prepared by Participants in the Biological Science Group*, Cooperative Study in General Education, auspices of General Education Board, Chicago, 1939.

answered by the behavior of *things*. In other words, the question must be so constructed that it refers to *something that actually exists* in the external world. For example the scientist cannot ask whether "mind" is more important than "body" or vice-versa, because the question has no meaning in the external world. It has no meaning because "mind" does not exist apart from "body." When one asks such a question he is doing with words what cannot be done in reality. He is therefore not asking a question but making noises with his vocal cords.

The reader will realize that we are already deep in linguistic issues by the mere process of proposing the above definition of the "scientific-method." Linguistic issues (in the broad sense of all human communication) underlie all "knowledge" in an educational sense, because our "ideas" and "thought" processes become useful and available only when they are conveyed to others by means of symbols or language.

Then if science is a method of minimizing the difficulties of human communication, and of making our verbal expression more closely related to external phenomena with which we are concerned, then it automatically makes a fundamental contribution to the very foundation of general education. I propose that this is true and shall briefly discuss this proposition. First however, I should like to point out that the issues involved are by no means new, or is interest in them restricted to a few investigators, as is well shown by the wide sale of Stuart Chase's book, *The Tyranny of Words*.[2]

It has been generally recognized that issues considered by the semanticist (from semantics—the science of meaning) are relevant to the logical foundations of science, but that certain of the practical semantic methods have pedagogical use in science, particularly in the biological sciences, is not so generally recognized. The particular system of semantics which I believe has most relevance to the teaching of biology is that called "General Semantics" formulated by Count Alfred Korzybski in his profound book, *Science and Sanity*.[3]

Before dealing with the specific pedagogical aids indicated by General Semantics I shall briefly describe some of the major concepts of General Semantics. This of course can only be done incompletely in a short paper, and in this attempt I beg the indulgence of other semanticists. If however one were to search for a "key-phrase" to General Semantics it would probably be found in "similarity of structure." This phrase is used by Korzybski in a similar way in which it is used by Russell,[4] and is well illustrated by Weinberg,[5] thus: a relation, P, between members of an ensemble, x_p, has the same structure as a relation, Q, between members of an ensemble, x_q, if there is a one to one correspondence between the elements of x_p and x_q such that whenever two elements of x_p are in the P relation to each other, their correlates in x_q are in the Q relation to each other, and vice versa. Korzybski's illustration of this point is that an accurate map of the United States has the same structure as the territory of the United States in that both the map and the territory would have Chicago between New York and San Francisco. In this example, the relation P would be the spatial order of the three cities which are the elements x_p; Q would be the spatial order of the points on the

[2] Chase, Stuart, *The Tyranny of Words*, Harcourt-Brace, 1938.

[3] Korzybski, Alfred, *Science and Sanity*, Science Press, 1933.

[4] Russell, Bertrand, *The Analysis of Matter*, Harcourt-Brace, 1927.

[5] Weinberg, Alvin M., *American Physics Teacher*, Columbia University, 7, 104, 1939.

map representing these cities, and these points would be the elements x_q.

Korzybski next sets up three premises which restrict the relations between the external reality (the territory) and the symbol (map) of the territory.

1. The map is *not* the territory.
2. The map *is not* all the territory.
3. The map is self-reflexive.

The first premise appears ridiculously silly. It seems obvious that everyone knows that the map is not the territory; that the symbol is not the thing symbolized. However the implications of this premise are far reaching. If the map (symbol) is not the territory (thing symbolized) the relation between the map and the territory must be a structural one. The map is accurate in the degree that its structure compares with the structure of the territory. The verbal symbol for a thing or event is accurate in the degree that its structure compares with the structure of the thing or event. For example the words "space" and "time" are poor symbols of external phenomena because they imply that "space" and "time" can exist separately—they show no *relation* between the two. "Space-time" is better because its structure compares with the structure of the external phenomena.

The second premise is not generally recognized. The map does not represent all the territory. The "word" or symbol does not represent all of the thing symbolized. We cannot have a perfect symbol, for a perfect symbol would have all the infinite physical, chemical, dynamic, etc., characteristics of the external thing. The symbol cannot cover all the thing, therefore through symbolism we cannot know all of the thing. We arrive at our symbolic representation through a process of abstracting the relevent characteristics from the irrelevant, and the irrelevant (judged by *us* to be irrelevant) are not present in the symbol.

This tendency of our symbolism to represent only part of the facts is called "elementalism," and Korzybski suggests the following semantic techniques as a constant reminder of the misleading effect of "elementalism."

1. Quotation marks: Elementalistic terms which imply a dichotomy which does not exist in nature are to be enclosed in quotation marks, *e.g.*, "mind," "body," "space," "time," etc.

2. Hyphens: To indicate the proper use of elementalistic terms, *e.g.*, body-mind, space-time, etc.

3. Et cetera: In any case the symbol cannot include all the characteristics of the thing symbolized. Therefore the user of such a symbol can signify his awareness of this limitation by adding "etc."; *e.g.*, "The factors which cause crime are poverty, heredity-environment, etc."

4. Dates: Symbols cannot have validity for all time. What we refer to by the symbol science is different in the case of "science 1870" and "science 1940."

5. Indices: Since no two objects are exactly similar in all respects, it is well to call attention to the absolute individuality of objects by the use of indices; *e.g.*, amoeba_1, amoeba_2, Jew_1, Jew_2, etc.

These semantic techniques are extremely simple yet they serve to keep the user aware of the limitations of the language he uses. That they are fundamentally derived from the exactness of scientific symbolism is self-evident.

The third premise is somewhat less recognized generally. The map is self-reflexive. That is, a perfect map of this township wherein I work would include the house in which I am, it would include me and also the map of the township. Therefore the map perfect must include the map of the map, the map of the map of the map, etc. This is also true of symbolism. A perfect symbol would include

the symbol, the symbol of the symbol, etc., which is patently impossible. This implies that it is possible to use words on different levels of abstraction, or that it is possible to speak of speaking, to think of "thinking." This is an interesting problem of language. It is only the scientist who can avoid it for he talks about the behavior of things, he does not talk about "words." One should not forget that when we symbolize a thing we are already on the third level of abstraction, for the thing itself essentially consists of submicroscopic electronic structure, *some* of the characteristics of which impinge upon our nervous systems. From certain of these characteristics to which our nervous systems are reactive we abstract a realization of the thing itself. Then from certain properties of the thing we abstract a generalization and apply a name to it. Therefore, by the time we first introduce a verbal symbol we have reached the third level of abstraction and have already left out many of the characteristics of the original event. From the symbol we continue to abstract by talking about the symbol. The scientist encounters this danger when he talks about theories, which are symbols for high order abstractions derived from talking about symbols. The theories of science derive their remarkable predictability because they are derived by a process of abstraction that begins always with the carefully observed and measured thing,—and is able to point to and exhibit those things upon demand. This process is impossible to reverse when for instance one talks about "patriotism." The referents, or the things from which the abstraction was derived are indeed difficult to find!

There are of course, many other aspects of General Semantics which cannot be considered in this paper, and to those whose intellectual curiosity has been whetted by this introduction, I can do no better than recommend the painstaking reading of *Science and Sanity*.

Proceeding from this introduction, I shall make two general premises upon which I shall base my contention that the biological sciences contribute fundamentally to the "general education" of the student.

1. Knowledge (as dealt with in education) depends upon human communication by means of symbols (language, mathematics, art, etc.).

2. An understanding of the nature, and an awareness of the limitations and pitfalls of linguistic expression is fundamental to any education.

If these premises be true, any intellectual pursuit which serves to illustrate the true relationship between symbol and thing symbolized, which makes the student aware of the process of abstraction, which makes the student better aware of the "meaning" of verbal expression, and which enables him to detect and understand things which can be done with words that cannot be done in reality, is a valuable and fundamental aspect of "intelligence" and therefore contributes to general education.

Let us now see what the biological sciences can contribute to such a technique or intellectual tool. I have already suggested that the essential character of science is that it asks its questions from the behavior of things,—and puts its questions in such a way that they can be answered by the behavior of things. This in turn implies that the student of science should first be a student of facts, and of the relationships between facts. Having observed facts and their relations with each other he should express his conclusions in linguistic terms which are true to the facts, *i.e.*, have similar structure. He then for instance knows that "evolution" is a verbal symbol for countless facts which in relation to each other suggest

the gradual development of organic types. He is fully aware that evolution is not a *thing*, nor a belief, but an abstraction from many facts and their relationship; a symbol which by necessity leaves out many of the things from which it was abstracted. A scientific "law" becomes an abstraction from observed factual relations, not a divine or infallible superimposed "rule."

In science one first observes the facts, or the behavior of things, recognizes his sensory perception of them to be incomplete because of the limitations of his nervous system and then abstracts from them his principle or generalization. He is distinct in his "method" because his criterion of "truth" is always the behavior of facts or things; he does not, cannot in science, indulge in purely verbal speculation.

I do not mean to minimize the importance of principles. They are indeed useful. I do mean however to point out that a principle is of real value and dependability when its user is aware of the method of its abstraction and therefore of its limitations and exceptions. From this it follows that it is erroneous to teach principles and generalizations *per se*, and to send students off with a nicely memorized matched set of principles and generalizations to apply experimentally to observed series of facts and relations. He should on the contrary be introduced to facts and be encouraged and assisted in forming his own principles from them. This process of forming principles tends to make the student aware of the whole process of abstraction, which also makes him aware of the difficulties inherent in translating actual external phenomena into verbal symbols and language. This particular awareness is the essence of true critical evaluation of linguistic propositions, of anything that is expressed in language. That is, I believe, wide enough an application to satisfy the most social-minded professional educator!

The critical reader will notice that the methods I have indicated thus far might be demonstrated equally well in many sciences. The peculiar contribution of the biological sciences lies in the fact that in addition to the aforementioned "method" of science the biological sciences deal with the study of the human body and its "mental" reactions, as an integral part of the subject matter. Through this subject matter the student can be made aware of the mechanisms by which he is conscious of the external world. He can be acquainted with the limitations and nature of his sense perception and through that knowledge understand the unreliability of raw sense "knowledge," *e.g.*, "the sun sets" which is a linguistic falsehood growing originally from the limitations of our sense organs.

In this respect the biological sciences can make immediate contribution to a field that is occupying the attention of many educators today, "Propaganda Analysis." The student who is aware that he can be conditioned to symbolism in the same sense that Pavlov's dogs were conditioned to give a definite response to stimuli will have a realistic attitude toward attempts to establish such conditionality in him. For example, when he realizes that his response of "aspirin" to the stimulus "Bayer's" is a cleverly established "conditional response"[1] he is apt to be more critical if one attempts to establish in him the conditional response of "persecute" to the stimulus "jew." The biological sciences, through encouraging the student to study himself as a human organism living in an environment which conditions him (and which includes a verbal environment) can contribute essentially to his orientation to that environment.

Conclusion

I believe that the teacher of any biological science can contribute fundamentally to the general education of his students by the use of the simple semantic principles which I have discussed for they will enable him to promote the growth of the student in the following ways:

1. In the ability to understand and evaluate the relation between language or symbols, and the things being symbolized.

2. In recognizing things which can be done with words, but not with things in the external reality.

3. In comprehending the discrepancy between the world as described and the world as it impinges upon him.

4. In understanding the nature and limitations of "theories," "laws," etc.

5. In understanding the sensory mechanism by which he becomes aware of the external world. (And the limitations of that mechanism.)

6. In his ability to investigate the truth of a verbal statement.

These qualities are, I believe, fundamental to "general education." And because they are natural products of the teaching of biological sciences with the methods of General Semantics, it is worth while for teachers of biology to investigate further along the lines suggested.

Oysters, Pearls of Nutrition

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If the teaching of a subject shows a practical phase that can be used in daily living, average students will remember the practical phase long after they have forgotten the theory. In the study of mollusks, the fact that oysters as a food for man have a better nutritional balance than most other items of food is something that students should know. This is supported by no less an authority than the U. S. Bureau of Fisheries. Circular No. 1–104, March, 1939, states, "Because of the high mineral, vitamin, protein and glycogen content, oysters are considered one of our most nutritive foods."

That oysters were thought to be "health-giving" in some obscure way is attested to by such ancient philosophers as Horace, Cicero, Pliny and others, although many will agree that "he must have been a bold man who first swallowed an oyster." Perhaps the survivor of that dare-devil feat is responsible for the theory that oysters were wholesome eating for the genus *Homo*, because all through history there are references to oysters and health. In the heyday of the Roman Empire, officers were served oysters that had been transported from England, packed in snow and ice, as it was thought that eating oysters enhanced virility. In Wales, "pale young women," were told to eat oysters and "they'd be rosy." All that an old theory has to do, it seems, is to live long enough for facts to be discovered that will prove or discredit it.

Take the 16th century classic, "It is unseasonable and unwholesome in all months that have not an R in their name to eat an oyster." In the light of today's knowledge we must conclude that this was intended for the oyster's sake not man's. We know that during the summer months, when oysters are spawning, it is not well to disturb them. Our forefathers in the 16th century knew this too;

so the classic was thought up. It proved much more effective than any law, and as oysters are less palatable just before they spawn and are thinner after spawning, it was easily enforced.

Today, however, scientific oyster growers grade and store their crop when they are at their best (in September) in large tanks filled with frequently-changed sea water. To the sea water is added a small amount of chlorine which kills the micro-organisms on which oysters live, and likewise clears the oyster's alimentary tract. Oysters are then at their best for immediate use and for preserving for safe shipment and long market life. With the rapid-freezing method now used the mineral and vitamin content remains intact and the delicate tissues are not broken down, so that oysters can safely be eaten the year round either raw or cooked. A brief résumé of the habits of oysters and of their food and care, will, in a measure, explain why they are nutritious.

It is logical to presume that some natural food requirements prompted our American Indians to feed so extensively on oysters. That they did so is shown by the trail of hundreds of oyster shell heaps found along the Atlantic Coast, with one heap at Damariscotta, Maine, estimated to contain millions of bushels of shells. Later, the Pilgrim Colonists who followed along the coast of Maine and New Hampshire took to eating oysters in such a big way that they practically "killed the goose that laid the golden egg," by overfishing. That may be why oysters are not now found in these areas except for a few scattered beds.

However, the Eastern oyster (*Ostrea virginica*) was found also in the bays and estuaries from Massachusetts to Texas, and today this species constitutes the bulk of the world's oyster industry.

The Western oyster (*Ostrea lurida*) found all the way from the State of Washington to California, although chiefly in the north, is a slower-growing, smaller oyster than the Eastern species.

The Japanese oyster (*Ostrea gigas*), which has been introduced on our Pacific coast, differs from our native oysters in that it grows more rapidly, is long and thin, and has an elongated and rather fragile shell. It is also considered inferior in taste. Experiments in crossing this species with the Eastern oyster have been tried, but recent reports indicate that the quality of the hybrid oyster is none too good. The fact that the Japanese oyster grows to marketable size in less than two years, whereas ours take from three to five years, gives the growers of the former an advantage. On the other hand, the rapid growth of the Japanese oyster often causes it to overgrow a marketable size.

Transplanting, as an aid in the culture of oysters, came about quite by accident. "In March, 1835," Dr. Lewis Radcliffe, Director of The Oyster Institute of North America, tells us, "a schooner laden with Virginia oysters arrived at New Haven, Connecticut, too late for that season's market. To avoid the loss of cargo, the oysters were dumped overboard into one of the nearby coves. The following fall it was discovered that these oysters had increased at least a third in size and were of most excellent flavor." This incident led to the transporting by schooner each season of hundreds of thousands of bushels from one area to another, and was the means of making oysters the most valuable of all under-water crops in this country.

In addition to having an almost unbelievable fecundity, some species of oysters have the ability to change their sex. During their first year they are usually male. During their second year about half of them turn into females and a lesser percentage change from male to

female yearly thereafter. This changing of sex seems to be influenced by the relative numbers of sperm and eggs in the surrounding water.[1] Males shed the sperm first, and a healthy male will discharge billions of motile sperm in a season. The milt clouds the water and acts as a chemical stimulus to the female which ejects her eggs in puffs, fifteen to one-hundred million eggs in one spawning. Oysters spawn several times each season if the temperature of the water stays around 75° F. In the Gulf Stream area the spawning season may last as long as six months in some years.

Fertilization of the eggs of the Eastern oyster takes place in the water and in a few hours free-swimming larvae (about the size of fly specks) develop. The free-swimming period lasts about two weeks, during which time each young oyster, or "spat" develops a "foot" with which it crawls onto some hard clean surface, there to "set" or "strike" by attaching the shell with a cement-like sticky substance. A metamorphosis then takes place which changes the oyster from a free-swimming larva to a stationary feeding organism.

In the Western oyster the eggs are not discharged into the water but remain within special brood chambers in the mantle cavity of the female. The eggs are fertilized by sperm brought in with the incoming current of water and are retained for twelve to sixteen days, when they are released to complete their development. They too, seek a suitable spot for attachment by the use of a "foot." Unfortunately, after nature has been so bountiful, less than one per cent of spat survive to live to maturity. As if that were not hard enough luck for oyster growers, they have constantly to fight off the oyster's natural enemy, the starfish. (At a recent meeting of oyster growers from New York, Connecticut and Rhode Island, it was decided that four hundred thousand dollars would be needed to fight the starfish menace in Long Island Sound which, according to Dr. P. S. Galtsoff, biologist of the U. S. Bureau of Fisheries, is undermining 47,000 acres of privately owned beds. In Buzzard's Bay, Massachusetts, a drive was made in 1934 and sixty million starfish were killed off.) Drills, mussels, boring sponges, leeches and clams, also cause a terrific amount of damage, but the starfish is the most deadly enemy. It fixes the suckers of its arms on each side of the shell and then injects an acid fluid into the water before it straightens out its arms. The oyster can resist considerable pulling but it cannot cope with the oxygen-less acid water which causes its adductor muscle to relax and its shell to open.

Oysters feed by opening their valves and drawing in currents of water through their gill chambers which act as filters. An adult oyster may filter water in warm weather at the rate of 27 quarts an hour, and filtering or feeding may go on for sixteen of the twenty-four hours in the day. The food consists of diatoms, peridians and other microscopic life, collectively known as plankton.

The age of an oyster, according to Dr. H. D. Pease,[1] can be determined by the rings in its shell, somewhat like the rings of growth in a tree. Each spring and fall the oyster deposits a dark, gummy lusterless type of nacre which forms curved plate-like rings at the edge of its shell allowing for expansion. On cross-sectioning a shell the alternate layers of this hard nacre are seen with a soft chalky material between. This development of the shell layers is related to the oyster's interesting life cycle which consists of sexual reproduction in the early summer

[1] "The Oyster—Modern Science Comes to the Support of an Ancient Food," *Journal of Chemical Education,* Vol. 9, No. 10, Oct., 1932.

followed by intense feeding in the fall, which makes for a rapid growth of shell and body, and prepares it for the intense cold and almost lifeless sleep of hibernation during the winter. In early spring it renews its feeding operation in preparation for its reproductive stage.

In France, oysters are generally green, due to the chlorophyll-like substance "Marennin" found in pure cultures of diatoms on which the oysters are fattened. Americans are usually shy about trying these oysters—which are rarely served on ice—even after they have seen —and heard—French gourmets noisily suck dozens of these oysters right from the shell—the only way the French will eat them. A taste must be cultivated for them as they are quite salty. At times some of our Eastern oysters cultivated in Connecticut waters have greenish-colored gills. This color is due to the presence of copper derived from certain varieties of diatoms which the oyster has ingested, and is not harmful.

It is not surprising that oysters contain appreciable amounts of copper, manganese, iron, calcium, phosphorus and iodine, when you consider the fact that sea water contains all of these organic minerals in approximately the proportion to which living things are adapted, and that oysters live on the minute sea-borne animal and vegetable life found in sea water. Dr. E. V. McCollum of Johns Hopkins University says, "Since oysters and clams are frequently eaten in the raw state, they occupy a unique position in that they are the only foods of animal origin which in temperate regions can take the place of fresh, raw vegetable foods." In addition to the mineral content, according to the U. S. Bureau of Fisheries (Circular 1–104) "Oysters contain vitamins A, B, C, D, and G, which are all necessary for the maintenance of a healthy body." And, to avoid monotony in oyster cooking, Uncle Sam's Economic Circular No. 58 issued by the U. S. Bureau of Fisheries gives 98 recipes.

Biology and the Classics

PHILIP H. POPE
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When I graduated from college I was very enthusiastic about Latin and Greek and their value in the scheme of education in general and science in particular. In fact I was quite surprised to find in graduate school that some of my fellow students had never studied these subjects and held them in contempt. In the twenty-five years that have passed since then their views rather than mine have prevailed in the schools, but in spite of that I am going to raise my voice in the wilderness to show why I still believe very much as I did then.

One of the saddest things about college examination papers, especially among freshmen, is the pitiful way the students flounder in what apparently seems to them a meaningless bog of Latin or Greek scientific terms. They misspell, misapply, and misuse all these things, when a moderate knowledge of the languages from which they are derived would give them the key to the whole system. To illustrate:

When I first saw the name Arachnida, the mythical story of Arachne flashed into my mind, how she was changed into a spider by Athena for her presumption in challenging a goddess to a contest in

weaving. Could I ever forget the class to which that name was given? Again such names of muscles as adductor femoris, latissimus dorsi, and platysma almost locate and describe themselves when you think of their derivation. It is true that a great many biological names are much less logical than these. I once tried to derive gopher from γῆ and φέρω to mean earth mover, and then found it to be the corruption of a French word, *gauffre*, meaning honeycomb. Nevertheless the times when I could look at a new word and grasp its meaning at once from its derivation and usage have been many. Spelling and particularly the formation of plurals can be sensed by a language student rather than memorized. Probably I often bore my classes by telling them the derivation of words I use in lectures. Without any background such things may not mean much to them, yet the need has been recognized sufficiently for a dictionary of Greek and Latin combining forms[1] to attain a wide sale.

I once showed a physician a century-old book called *The Home Medical Advisor.* He looked it over and smiled at such medicines as tobacco and the advice given for reviving babies suffocated by cats lying on their mouths, but he added: "There is one thing about those old books, they were well written. In those days the doctor was an educated man; now he need know nothing but his specialty, and some modern medical books are so badly written that they are hard to understand."

This article deals only with the application of Greek and Latin to science, so I must pass by the excitement of the battles described by Xenophon or Caesar and the pure joy of reading Homer and Virgil in the original, noting how often the Roman poet borrowed ideas from the Greek. Perhaps that is not altogether beside the point though, for I recall an English teacher saying that she found a very definite correlation between a student's reading and his ability to write.

When I entered high school I had blundered through most of an English grammar and passed an entrance examination, but such words as adverb, article, subjunctive, conjugation, and declension meant practically nothing to me. The rhetoric that was given me in the freshman English course offered no enlightenment, but Collar and Daniel's *First Year Latin Book* threw a flood of light on the whole subject. There, laid out like a map, was the entire plan of a language in a plain, understandable form. When I had finished the book, under the guidance of an unusually stimulating teacher, I had a grasp of English that I could never have gained from any grammar or rhetoric that I ever saw. Why can't it be done without going back into dead languages? Because English is such a hodge-podge of older languages that its grammar is a sorry mess like its spelling and pronunciation. As a start for the comparative anatomy course we always dissect the dogfish for the same reason. There, in a simple, understandable form can be found the essential parts of such complicated structures as the nervous and circulatory systems. In the human body these things are extremely complex, but the medical student who knows his dogfish will find that he has the key to them in his hand, as the student of modern languages will find if he knows his Latin. As I was writing this (during an examination, don't tell!), a student asked me the meaning of the word terrestrial. I said, "Have you had French or Latin? What does the first syllable mean?" She understood.

[1] Jaeger, E. C., *A Dictionary of Greek and Latin Combining Forms used in Zoological Names,* Chas. C Thomas, Pub.

My experience in beginning Latin in high school was very fortunate, for I had it under one of the best teachers I have ever seen in any subject. She emphasized the interesting parts of material that is often considered dry: the relation of both words and grammar to our own language and the connection of it all to history and literature. I remember when somebody asked her what was the use of studying Latin. She turned the question back to us and we spent the rest of the period discussing it.

Probably for every one to agree with me, there will be ten to say this is old stuff, rejected long ago and left on the farther shore of Lethe (if that word means anything to them). That if our children fail to grasp English as it is taught, then change the method of teaching (no doubt the ideal method of teaching will at once jump up to meet the need!), but don't drag them through the mazes of a dead language that they will never use.

I would not go back forty years to the days when both Latin and Greek were required for college entrance. Too many good minds have no language sense or appreciation of ancient cultures for that. On the other hand, too many fads have come and gone in the educational world within my memory to make me think it wise to reject completely the old methods that have given inspiration to thousands. Latin is still fairly popular in the local high school; now and then some student goes elsewhere for Greek, and I wish it were still available for those who want it.

Some say that Latin is usually badly taught in high school. Possibly so, but I doubt if that is more true of Latin than of most high school subjects. Certainly the local teachers under whom my daughter is now working still feel it their privilege to pass on a spark of the divine fire that Prometheus brought down, and I hope that their type may live long and continue to attract the brightest of our children.

Alternation of Generations

FRED. M. SCHELLHAMMER
Evander Childs High School, New York City

It is a common concept that like begets like. Among the more common animals it is "usual" for the young, though immature, to be similar both biologically and morphologically to the parents. However, there are exceptions to this concept, and alternation of generations is one of them. Alternation may be defined as the occurrence, in one life cycle, of two or more forms, each different from the other and each differently produced.

Chamisso, in 1819, as the result of his investigations on Salpa, a tunicate, came to the following conclusion which, though couched in somewhat cryptic form, is certainly as applicable to-day as it was then. Said Chamisso:

> "A Salpa mother is not like to its daughter, or its own mother but resembles its sister, granddaughter, and grandmother."

In 1845 Steenstrup, after reviewing the observations that had taken place on alternation, set forth his own work on the trematodes and crystallized the con-

cept of alternation.[1] According to Steenstrup alternation was:

"A natural phenomenon in which an animal produces an offspring that at no time resembles its parent but which, on the other hand, brings forth a progeny which returns in form and nature to the parent form so that the maternal animal does not meet with its own resemblance in its own brood but in its descendants of the second, third, or fourth generation: this takes place, in the animals which exhibit the phenomenon, in a determinate generation or with the intervention of a determinate number of generations.

"These phenomena can not be looked upon as metamorphosis or transformation since a metamorphosis implies a change which occurs in the same individual, not a series of individuals."

With this background of the early concept of alternation in mind it might be well to examine briefly the manner in which alternation occurs. The common liver-fluke (*Distomum hepaticum*) and other trematodes which exhibit the phenomenon are satisfactory examples. The mature liver-fluke is autogamous, laying self-fertilized eggs. These pass through the bile ducts and are dropped with the excreta of the sheep. If water and a suitable temperature are among the environmental factors, the egg hatches into a ciliated larva which either enters a small fresh water snail or dies within a few hours. If the snail is entered, the ciliated larva becomes a sporocyte within which develop five to eight secondary larvae and these, in turn, to several series of larvae. The final series are small tailed larvae which leave the dying snail and encyst on the grass. If ingested by a sheep they pass finally into the liver and mature.

It should be noted that, in this type of alternation, there is a series of larval generations within the life cycle. Also, in the development of larvae from larvae, without fertilization, we have an example of parthenogenesis as well as paedogenesis, that is, reproduction of offspring by unfertilized larval forms.

Among the coelenterates alternation was observed in the nineteenth century. The life cycle of *Obelia geniculata* is typical of metagenesis, that is an alternation of a sexual with an asexual generation. The asexual colony is a fixed, vegetative, plant like, hydroid colony which is anchored in littoral waters and which buds off swimming bells during the summer months. The bells are free swimming and dioecious. Their fertile eggs develop into free swimming larvae which settle down as polyps and form new arborescent colonies.

Although the phenomenon of alternation was first observed among animals its occurrence among plants is well known. The common fern exhibits two distinct forms, the conspicuous phase consisting of roots, stem, and fronds which is characterized by the diploid number of chromosomes. Spores are borne on the fronds; the conspicuous fern plant is, therefore, a sporophytic structure. The maturation of spore mother cells gives rise to the gametophytic or haploid phase, the thallus. The gametophytic phase is the sexual stage and the fertilization of the megagamete again initiates the sporophyte.

It should be emphasized that in animals there is no alternation of a sporophyte and a gametophyte: both generations in animals have the diploid chromosome number, alternation consisting merely of an asexual generation followed by a sexual generation.

Having briefly reviewed these examples it might be well to turn to a general consideration of alternation in the plant

[1] Steenstrup, Johannes J. *On the Alternation of Generations*, translated from the German by G. Burk. Ray Society, London, 1845.

and animal kingdoms. From the historical angle, the name of Hofmeister is outstanding in the plant kingdom. Camerarius, 1640, had indicated the significance of pollen in the production of viable seed, and observation of the pollen tube had been made by 1837. But a maze of conflicting theories concerning the significance of the entire reproductive process had sprung up and it was not until 1849 that Hofmeister stated that in mosses, as in ferns, there was an interruption of the vegetative process by sexual procreation. In 1851, he was able to show the occurrence of alternation among the seed bearing plants as well. Sachs[2] has written of him that his investigations

"were magnificent beyond all that has been achieved before or since in the domain of descriptive botany. Alternation of Generations, lately shown to exist in the Animal Kingdom, was proved to reign according to a simple scheme throughout a long series of different plants."

It would not be possible here to trace the occurrence of the phenomenon throughout the plant kingdom. It is well to indicate that discoveries continue among the thallophytes at the present time. Papenfuss[3] indicated the occurrence among certain brown algae, Drew[4] among the red, and Kylin[5] has reviewed the types of alternation among the red, brown, and green algae.

[2] Sachs, Julius von. *History of Botany*, revised English edition by I. B. Balfour. Clarendon Press, Oxford, 1890.

[3] Papenfuss, George F. "Alternation of Generations in Ectocarpus Siliculosus." *Bot. Gaz.*, 96–3. 1935.

[4] Drew, Kathleen. "Contributions to the Cytology of Spermothamnion Turneri." *Ann. Bot.*, 48–191. 1934.

[5] Kylin, H. "Besiehungen zwischen Generationswechsel und Phylogenie." *Arch. Protistenk.*, 90–3. 1938.

Alternation is not uncommon among the invertebrates. Indication has already been made of the occurrence among the tunicates, trematodes, and coelenterates. Sars, in 1828, and Siebold, in 1837, were responsible for the earlier observations on alternation. Among Sporozoa a period of asexual reproduction terminates in gamete production. The latter, by conjugation, give rise to zygotes which multiply to form the infective sporozoites. Among the Foraminifera, microspherical asexual individuals give rise to a series of agametes which develop into macrospherical individuals. At maturity the protoplasm of these divides into gametes which, after fission, form the microspherical generation.

Among the coelenterates reference has been made to Obelia. The so-called "jellyfish," *Aurelia aurita*, also exhibits metagenesis, the free swimming medusoids being the prominent stage and the sessile hydra-tubae being subordinate.

It is among the hexapods that most complicated alternations sometimes occur. Miastor is of particular interest inasmuch as it illustrates metamorphosis, paedogenesis, and parthenogenesis as well. Under favorable environmental conditions oocytes develop parthenogenetically within the larvae. A number of daughter larvae are thus produced and set free in the body cavity. Having used the parent as a host, these emerge and the process may be continued indefinitely. However, with temperature variations, larvae occur which transform into pupae and finally emerge as adults. The paedogenetic larvae are, of course, all females, whereas the pupated larvae may be of either sex.

One of the grape insects, *Phylloxera vastatrix*, exhibits an interesting form of alternation. The life cycle includes a

(*Continued on page 107*)

Third Annual Convention

of the

NATIONAL ASSOCIATION OF BIOLOGY TEACHERS

in conjunction with

The American Association for the Advancement of Science

meeting at Philadelphia, Pennsylvania
Christmas Week, 1940

PROGRAM

General Meeting for Members and Friends, Monday, Dec. 30, 1940
in Room 100, Hare Hall, University of Pennsylvania

MORNING SESSION 9:30 A.M. to 12:00 Noon

Charles E. Mohr .... "How Biology Teachers Can Use a Museum"
B. F. Howell .... "The Role of Paleozoology in Modern Biology"
Mary Oliver Ellington .... "Guidance Through the Teaching of High School Biology"
Berwind P. Kaufmann .... "Working with Chromosomes"
Oscar Riddle .... "An Inventory and Accounting Just Rendered by Thirty-two Hundred Teachers of High School Biology"

Luncheon

Our members have been given a special invitation to attend the luncheon of the *American Science Teachers Association* at 12:30 in the Bellevue-Stratford. An address and demonstration on *Taste and Smell,* illustrated by materials passed out between courses, will be given by Dr. Albert F. Blakeslee, President of the American Association for the Advancement of Science, and Director of the Department of Genetics, Carnegie Institution of Washington, Cold Spring Harbor, Long Island, N. Y.

AFTERNOON SESSION 2:00 P.M. to 4:30 P.M.

John B. Lewis .... "Photomicrography for the Advanced Beginner"
Logan J. Bennett .... "Biology and Wildlife Conservation"
L. O. Nolf .... "Trichinosis"
Alfred C. Kinsey .... "A Scientist's Responsibility in Sex Education"
Nathan A. Neal .... "Biology and the Newer Philosophy of Science Teaching"
Charles W. Hoffman .... "The Electron Microscope"

N.A.B.T. **Annual Dinner,** Dec. 30, 1940
6:30 P.M., Hotel Robert Morris. $1.00

Reservations may be made at our
headquarters in the Hotel Robert Morris
Guests and friends are cordially invited
Dr. C. C. Little, guest speaker

President, George W. Jeffers
Program Chairman, Homer A. Stephens

Headquarters at the Hotel Robert Morris

President's Page

THE CHRISTMAS MEETING

According to custom, *The National Association of Biology Teachers* will again hold a one-day program, meeting in conjunction with the Annual Christmas Convention of the American Association for the Advancement of Science, which this year meets in Philadelphia. Our President-elect, Mr. Homer A. Stephens, has been getting together the program which is printed on another page of this Journal.

You will note that there will be a morning and an afternoon session on Monday, December 30, to be followed by a dinner in the Robert Morris Hotel at 6:30. Last year our dinner was a very pleasant affair, and this year it promises to be even more so. The speaker of the occasion is Dr. Clarence C. Little, an outstanding biologist and a fascinating speaker.

Although the general meetings for the presentation of papers will be on the University of Pennsylvania Campus, Headquarters for the National Association of Biology Teachers will be established at the Hotel Robert Morris. (For rates at this hotel, see the advertising section.) Here the Executive Board will come together on Saturday afternoon, with maybe a session on Sunday also. I should like to point out that local biology teacher organizations, either affiliated or interested in affiliation, may send a delegate to the meeting of the board. Such delegates may present matters for consideration and may participate in discussion, but they are not entitled to vote. Here is an excellent opportunity for local chapters to become acquainted with each other and with the official family of the Association. On our part, it would be an excellent means for the National Association to learn of the desires of local groups.

I should like also to call attention to the fact that it will soon be time to make nominations for the 1942–43 officers. There is a provision in the Constitution whereby an affiliated group may nominate persons for office in the National Association. Even though this provision has hitherto not been availed of, we are always on the look-out for new blood. If you know of an individual who has shown characteristics qualifying him to hold office in our organization, I wish you would send information to our immediate past-President, Mr. Malcolm D. Campbell, Dorchester High School for Boys, Boston, Massachusetts.

Please feel free to look up your officers while in Philadelphia, even though you have to break in on the meeting of the Board.

The American Nature Study Society has extended a cordial invitation to our members to attend the meetings of the Society in Philadelphia. The first session will be held on Thursday evening, December 26, at 8:00 P.M., at the Academy of Natural Sciences. On Friday and Saturday, both morning and afternoon sessions are scheduled at the Ritz-Carlton Hotel. At all these meetings, programs of interest to biology teachers will be presented.

R. E. Snodgrass will deliver the annual public address of The Entomological Society of America on Friday evening, December 27, on "The Evolution of the Arthropods."

Notes and News

The American Nature Study Society will hold a two day meeting in Philadelphia on Friday and Saturday, December 27 and 28. Dr. George W. Jeffers will speak at their breakfast on Saturday morning on "Nature Interpreters."

Biology Teachers Interested in Exchanging Positions for one year are requested to write to R. C. Wilkins, Central High School, Superior, Wisconsin.

The Teaching Biologist, published by the New York Association of Biology Teachers, announces a special offer of five worthwhile issues containing courses of study, teaching techniques, testing devices, bibliographies, and other practical matter for one dollar. These issues are: Anthropology, Nov., 1939; Consumer Education, Feb., 1940; Genetics, Apr., 1940; Nature Issue I, May, 1940; Nature Issue II, Oct., 1940. Single copies are 25 cents and a yearly subscription (8 issues) $1.50. Orders should be sent to Philip Goldstein, Walton High School, Reservoir and Jerome Avenues, The Bronx, New York.

The Kansas Association of Biology Teachers reports the election of the following officers for the coming year:

Dr. John Breukelman, State Teachers College, Emporia; President.
Mr. Ira M. Hassler, Community High School, Chapman; President-elect.
Dr. J. Ralph Wells, State Teachers College, Pittsburgh; Vice President.
Miss Gladys Beck, Wyandotte High School, Kansas City; Secretary-Treasurer.

Harold F. Stallsmith, biology instructor in the Dayton Public Schools, Dayton, Kentucky, would like to exchange tropical fish for marine animals or other tropical fish. Those interested should communicate with him directly.

The Southeastern South Dakota Biology Teacher's Association met at Yankton College on November 2. About fifty were in attendance. Dr. A. P. Larrabee of Yankton College and John E. Hale of Yankton High School acted as co-chairman. The morning program consisted of a conducted tour of the State Hospital near Yankton. The afternoon program was as follows:

Address of Welcome, Dr. McCorrister, President of Yankton College.
"The Insulin Shock Treatment as a Cure for Mental Diseases," Dr. F. W. Hass, Superintendent of the State Hospital.
A paper on the relationship of scholastic grades and personality, Dr. Ward L. Miller, State College.

H. I. Maggrett was re-elected secretary for another year and Dr. John K. Edwards of Sioux Falls College was elected chairman of the next meeting, to be held in Sioux Falls on Saturday, December 14.

LOCAL ORGANIZATIONS AFFILIATE WITH US

The list of local associations affiliated with *The National Association of Biology Teachers* has recently been increased by four. The new members are:

The Delaware Valley Biologists Club.
The Biology Section of the Central Ohio State Teachers Association.
The Southeastern Illinois Science Teachers Club.
The Biology Section of the Wisconsin State Teachers Association.

From the beginning it has been the policy of the National Association to work through and with the regional groups in advancing the interests of biology teachers the country over. Individuals who are interested in the formation of local organizations are urged to communicate with the National Secretary-Treasurer or the President, for advice and assistance.

We extend a cordial welcome to the new members.

The Demonstration Laboratory for Biology

ROBERT C. CLARK
State Teachers College, Whitewater, Wisconsin

For many years the laboratory method in biology has been accepted as essential to the scientific method, but progress in the refinement of our laboratory methods has lagged behind our new view-points. In the minds of many teachers, there is no substitute for dissection as a means of learning the structural relationships of plants and animals. However, if we observe carefully and sympathetically the progress of students, keeping in mind always that biology makes a definite contribution to their attitudes and ideals, we cannot escape the conclusion that many young people receive wrong impressions of life from some of our present methods in the laboratory. Many persons are shocked and greatly disturbed when they are required to dissect certain kinds of animals, and the impressions which they take away are a distinct and deep-seated apathy or a complete disgust with the things they had been required to do. Thus, instead of creating a genuine interest and enthusiasm for this essential part of their education, we are actually defeating the objective toward which we strive in biology; and at the same time, are giving them materials which they build into a distorted philosophy of life.

With this condition in mind, may we not approach the subject from the point of view of saving those recognized values of laboratory approach, and at the same time, eliminate some of these undesirable characteristics? With this as an objective, we have planned several courses in the college freshman biology and high school biology classes, in which we have eliminated the required routine of dissection. From several years of experience, there is evidence of genuine progress in this new approach. The laboratory technique which has been used, seems to preserve the value of contact with living things and gives a wholesome opportunity to critically observe actual specimens. By this method, the student does not obtain that artificial or chart concept of biology as occurs when the laboratory is not used. This protected contact with life certainly eliminates the fear complex so often found, and reduces the possibility of injuring those finer sentiments which are a part of every person's character.

The most encouraging feature of this new procedure is that it stimulates the student to do individual work and offers a large opportunity for developing initiative and individuality. After considerable changes in methods and procedures, the following outline is indicated as the conclusion of our efforts and objectives this far in our experiment.

A series of laboratory problems are devised with some familiar type selected to illustrate some definite biological principles. Various textbook assignments and references lead the student to a general understanding of the problem, its relations to previous problems and its connection with subsequent study. Questions and discussions emphasize the major points of study.

By means of charts, lantern slides and models, various structural and functional

relations are thoroughly explained to the class. In this preparation, the student makes designated drawings, in which we use a system of differential coloring for important structures and systems, emphasizing, however, the importance of the various structures. Oral and written quizzes are given at various intervals to indicate progress and to clear up various difficulties. The work up to this point is necessarily somewhat artificial, but the fundamental purpose is served by laying a definite foundation for the study of the forms themselves. This phase of the work we have chosen to call the "demonstration" laboratory procedure, and is, in fact, a "preview" of the coming laboratory experience.

In the next step, the student has access to a selected group of experiments and specimens covering the animal or plant group which is being considered. Wherever possible, living forms are first studied, then prepared or preserved specimens are used, followed by various special dissections. The dissections have all been prepared by expert technicians, and illustrate with real material what the student has studied in the preview and demonstration laboratory. In addition to the type forms observed, there are a great many related forms. This enlarges the concept of that particular phylum of animal life and gives numerous illustrations of transitional forms that connect it with the preceding or subsequent groups.

After the student has made a careful survey of the entire series of specimens, he is required to select some special form that is of interest to him. He makes a careful study of its life history, its various characteristics, its biological significance in the economic world; and from various sources, gets a complete picture of this form. If possible, his preparation is presented to the entire class. This, however, is optional and in large classes sometimes impossible.

From the student's standpoint, this approach saves a great deal of time and establishes habits of study that are truly scientific. The greater accuracy in details of carefully prepared specimens are an incentive to critical observations and scientific comparisons. The great variety of specimens available gives a broad concept of the subject and makes possible the illustration of many biological principles and relationships that are not possible in the old procedure.

Also, from the teaching standpoint, there are many advantages. The specimens are mounted in uniform glass containers and can be arranged in groups for definite objectives. There is no need for long hours preparing dissected specimens and materials. The equipment necessary is very insignificant as compared with dissecting instruments, pans, etc., so common with other methods. Also, the material is not wasted and does not have to be replaced. The specimens are relatively permanent, there is little breakage, and with each succeeding year, many new specimens can be secured. It is a real challenge to the teacher to plan a demonstration museum and watch it grow year by year.

Let us now visit such a demonstration laboratory. The students are studying a problem entitled "Complex Body Organizations"; and the type forms used are specimens selected from the various phyla of worms, using the earthworm as an example for introducing the subject.[1] The instructor has reviewed the important objectives of the problem, emphasized the bilateral symmetry, segmentation, the various systems and their position in the body, with special emphasis

[1] A detailed outline of "Complex Body Organizations" as presented by our cadet teachers will be sent to any one interested. A request to the author will be gratefully acknowledged.

upon the function of each. Charts, models and various drawings on the blackboard emphasize all of the important points. A set of questions and discussion topics are assigned. In the discussions, the habitat and distribution of the earthworm are noted, its relation to soil and agriculture emphasized, and its life cycle is carefully studied.

When the instructor is convinced that the students are familiar with these general facts, the students are required to draw from designated charts, lantern slides or models the various important structures, and indicate their function and significant facts associated with each. These drawings are made in different colors and carefully labeled. Each system is indicated by a standard system of coloring. A quiz follows this part of the work. Other forms of worms such as *Planaria* and various parasitic worms are also studied to enlarge the general concept of the heterogeneous group known as "worms."

You will observe that the student has now made his own reference charts and has directions for the next step in the work. In this second phase of the laboratory approach, he finds a large group of prepared specimens in glass jars, arranged and labeled. These may include the common segmented form, *Lumbricus*, as well as the sand worm and other marine annelids. Also various specimens of the flat worms, some of the tape worms, the round worms and other parasitic types are available for observation and study. A number of microscope slides of cross sections through special parts of the body of *Planaria* and the earthworm are also available. Special slides show various aspects of infestation by parasitic worms and many other interesting phases of the problem of parasitism.

The student makes a complete survey of all these specimens, learns their classification, their significant characteristics and life habits, and general methods of culture or control. By means of notes, sketches and drawings, he secures a fairly complete picture of these various phyla of worms. Then he selects some interesting form and makes a study of it. For example, he may select the tapeworm of the dog, *Taenia serrata*. From the specimens he makes various drawings; and from the slides, studies the detailed structures; but most important he learns thoroughly the life cycle and the methods of control. In a brief review, he summarizes his findings before the entire class.

An oral or written quiz follows this preparation, using the specimens as review and quiz material. It has been my observation that our students acquire a comprehensive picture of the animal which they have studied, besides a wealth of detailed knowledge of special forms and their functions and relationships. Each problem follows in a sequence designed to show the relation of the form studied to the preceding ones, and to bring out the phylogenetic significance of the entire series. This procedure has those values which inspire the student to continued study. As a result of the stimulated interest, our advanced classes have more than doubled in attendance. Also, the facts and concepts of biology stimulate definite functions in the lives of the students. Our bulletin board is constantly filled with pictures, clippings and interesting articles about the things we are studying. Many discussions and arguments stimulate extensive reading, and requests for information of specific problems has greatly increased.

Many of our students have gone out as teachers, using this procedure in their biology classes; and it is the encourage-

ment which comes from them which has given us the incentive to continue and to improve the methods. Following requests for guidance in this method from the teachers now working in the high schools, our department is planning to continue its study and to put these methods into a definite manual or work book for the general high school biology classes. Such a series of studies will be available in a few months, and the cooperation of those interested in the improvement of their teaching technique and laboratory methods is solicited. Such methods need constructive criticism to make them even more useful. The author will welcome suggestions and criticisms from teachers of biology.

Portable Loan Exhibits as Teaching Aids

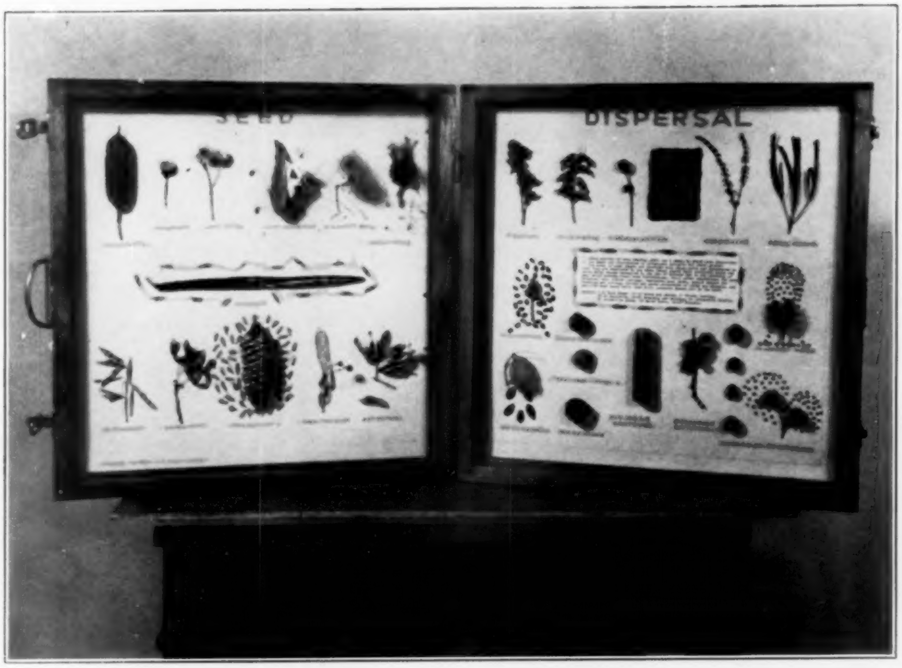
WALTER P. NICKELL
Cranbrook Institute of Science, Bloomfield Hills, Michigan

Within recent years practically all the museums of natural history throughout the country and many of the public school museums have made rapid strides in the development and use of portable loan exhibits as aids in teaching the various branches of natural science. The Educational Divisions of many State Departments of Conservation also, are using these exhibits for the frequent "shows" at which they are requested to display materials designed to educate the public in matters concerning wild life and conservation.

The types of these exhibits are many and varied, according to purpose, need and space available. From the standpoint of physical construction they may be classified roughly under two headings—flat exhibits and dioramas. Flat exhibits include enlarged photographs and paintings of wildlife and other subjects, actual leaves of trees, flowers, seeds, insects, minerals, fossils, shells, rocks, etc., which may be displayed upright against backgrounds or lying flat upon tables, shelves or in display cases.

Perhaps the most satisfactory type of flat exhibit case for most subjects that has been developed within recent years is what has come to be known as the suitcase exhibit (see Figures). This type of case embodies several features which should recommend it to users in all kinds of situations. It consists of two glass-fronted frames of any dimensions or thickness desired, within thirty inches square and three inches thick for each frame. These are held together by hinges and fastened with trunk fasteners. In the top is a collapsible handle by which it can be carried as one carries a suitcase. The glass fronts fit in grooves in the frame and can be removed easily in order to reach the exhibit. The stiff cardboard on which the exhibit is mounted is held in place at the back of the case by small strips of molding or quarter-round. One end of each frame is fastened with long slender screws so that both glass and exhibit can be removed when necessary.

Two especially important needs are met by the suitcase exhibit; the protection of the two glass fronts, which are turned together while in transit, and its



adaptability to an upright position without support when opened for exhibition. The cost of building a suitcase exhibit $18'' \times 18'' \times 1\frac{1}{2}''$ with masonite or plywood backs and glass fronts, including fixtures, is approximately two dollars, if built in the school craftshop.

The following list of suggestions which will make attractive and educational exhibits in this type of case may be helpful.

1. The range of autumn coloration in leaves.
2. Leaf outlines and leaf margins.
3. Lobed, simple, and compound leaves.
4. Leaves of common trees of any locality.
5. Poisonous shrubs and those commonly mistaken for them. (Poison sumac and staghorn sumac; poison ivy and Virginia creeper.)
6. Individual variation in white oak leaves.
7. Types of seed dispersal.
8. Leaf mosaics and rosettes.
9. Types of insect galls.
10. Mimicry and protective coloration in insects.
11. Insect pupal cases, cocoons, egg masses, etc.
12. The evolution of Indian flint artifacts.
13. Types of bird feet.
14. Epidermal modifications in animals. (Feathers, nails, horns, hooves, hair, etc.)
15. Nests of common birds.

As can be seen from this list, the greater amount of material necessary for making a series of comprehensive exhibits can be gathered by students and teachers themselves and arranged in exhibits to suit a great number of subjects. Many of these materials can be obtained from vacant lots or parks in the cities or from week-end trips to the country. Moreover, summer vacations or journeys across the country can become doubly recreational and profitable when both teachers and students have the incentive of collecting with a definite purpose in mind.

Dioramas are somewhat more difficult to construct and cost more, but many subjects and ideas which cannot be adequately illustrated in flat exhibits, can be well handled in the diorama type of display. Some of the best of these exhibits are those which are arranged in the

form of miniature habitat groups, showing in considerable detail the typical situation in which the animal or plant lives.

As an example of this type, I suggest the principle of avian parasitism and defense to illustrate the construction of such a situation. A strongly made box two and one-half feet high by two feet wide by twelve inches deep is sufficiently large to contain the necessary illustrative materials. The central figures in this group are the female cowbird, the female yellow warbler and its double or multiple layered nest, with the males of both species filling somewhat secondary rôles. Then, of course, accessories such as grass and branches of small trees or shrubs are necessary in order to reconstruct the natural setting in which the yellow warbler would be found nesting. In this same category, and of almost equal importance, is the painted background which gives perspective to the scene in the foreground.

The back of the case on which the scene is painted should be in the form of a half oval or half ellipse. The scene itself in its simplest form may be a few patches of blue sky with white clouds, but a much more effective total setting can be produced by depicting a small lake surrounded by shrubs and small trees, which are so typical of the yellow warbler's nesting sites. Beyond the lake shore opposite the observer a low line of more or less indistinct trees with alternating patches of blue sky and white clouds above, add to the impression of distance. This is necessary to the production of as complete a natural situation as possible. Groups of this kind in the classroom offer the nearest approach to a study of natural situations that one can find outside the large scale habitat groups of the natural history museums.

Another type of dioramic exhibit much in use in some museums and in loan cases is the arrangement of birds, animals, etc. in certain categories with relation to classification or associations. All backgrounds and accessories are eliminated in this type. Examples may be found in labelled displays of mounted specimens such as the "Resident Birds of Southern Michigan," "Some Common Birds of Thicket and Hedgerow," or "Some Common Bird Travellers."

The values derived from the construction and use of portable exhibits of the types mentioned above are many. Perhaps the most important value of all is the research which the collection and proper arrangement of materials entails. Teachers and students who construct their own exhibits will come to feel in their efforts a just pride which never can be approached by those who purchase their exhibits ready-made from supply houses. In this process the creative urge and the urge to collect,

two of the strongest impulses inherent in human nature, are brought into full play with a resultant purposiveness rarely encountered in the average classroom. Thus learning and creativity work hand in hand in a fashion which commends them to both teachers and students in an ever increasing ratio.

A CHRISTMAS SUGGESTION FOR THE BIOLOGY CLASS

On the last day before the Christmas vacation, there is often a spirit of restlessness in the classroom. Experience proves that the last class period can be used to best advantage if the work is so planned as to take cognizance of this fact. I suggest the following method.

Several days before the close of school the students are informed of the plan and are asked to select some topic which is related to both Biology and Christmas. This topic is prepared to be given orally on the last day. They are urged to make it as interesting as possible, not only in the manner of expressing their thought, but also by the use of real specimens and other illustrative material. The amount of time alloted for each topic will depend, of course, upon the length of the class period, and the number of students in the class.

A student chairman or master of ceremonies is selected to preside over the class on the appointed day. His duties are to arrange the topics in some logical sequence, and to make a fitting comment as he introduces each speaker. For example, in introducing the first speaker whose topic is "Myrrh," he may say, "There is one topic which, though it concerns a scrubby tree, will give us the proper mood and setting because of its association with the very first Christmas nineteen hundred and forty years ago."

Following is an excerpt from one of last year's topics.

Mistletoe

The mistletoe is an evergreen plant with white berries. It is parasitic on the apple and other fruit trees, on the thorn, the oak, the poplar, the lime, the ash, and other trees. It sometimes kills the branch or even the entire tree on which it lives as a parasite. The seeds are distributed by birds which eat the berries.

Mistletoe is found in the United States, in Europe, and in the Northern part of Asia. It was deemed sacred by the Druids, and today it finds a large market in the United States and England when preparations are being made for Christmas festivities and sports. Bird-lime is made from the berries, too.

Kissing under the mistletoe originated in Scandinavian mythology. When Balder was born, his mother went to all the plants to receive from each a pledge of willingness to protect her son. Much like the Greek Achilles, one spot was vulnerable. In this case, she overlooked the mistletoe. The wicked spirit, Loki, hated Balder who was the favorite of the gods, and making an arrow of mistletoe gave it to Hoor, the blind God of darkness, to test. He shot the arrow and killed Balder, who was later restored to life, and the mistletoe was given to the goddess of love to keep. Everyone passing under it received a kiss as a proof that it was an emblem of love, and not of death.

Here is a list of other popular subjects which have been successfully treated:

1. Origin of the Christmas Tree.
2. The Christmas Cactus.
3. Various fruits like cranberries, raisins, figs, dates, pomegranates and persimmons.
4. Decorative plants like the holly, poinsettia, Christmas rose, ferns, lycopodiums, and chrysanthemum.

5. Various nuts like the Brazil, almond, walnut, and pecan.
6. Mince pie and pumpkin pie.
7. Various topics related to animals such as Geese in Lithuania, The Pig on Christmas Morning, Peacocks, Turkeys, Reindeer.
8. Poems such as "The Mistletoe" by Bryan W. Procterand, and "Hunting the Wren" by Florence Boyce.
9. Paper, cellophane, cardboard, boxes, Christmas cards, and glue.
10. The Rubber Plant.
11. Dyes.
12. Christmas shopping.
13. The Yule Log.
14. Candles.
15. Corn Products and their bearing upon Christmas.
16. Christmas Cribs.
17. The Relation of Yeast and Bacteria to Christmas.
18. Frankincense.
19. Myrrh.
20. The Camel and Christmas.
21. My Mother's Center Piece.
22. The Christmas Stocking.
23. Santa Claus.

The classroom may be somewhat transformed for the occasion. If the seats are moveable, arrange them in the form of a circle. Place a table in the center of the circle, and set upon it a plant or two decorated for the event.

An appropriate Christmas carol or two sung at the beginning of the period also adds to the spirit of the hour. A student specializing in music may be asked to direct this part of the program.

We have found that this procedure gives us a good opportunity to integrate Biology with such subjects as English, Mythology, Art, Music, Speech, Home Economics, History, and Biblical Literature. The instructor as well as the students of both high school and college have found that a class period so used can be very interesting.

The education thus received really reaches further than the individual class members, for the students have frequently reported on how interested their parents, grandparents, and friends were in the biological facts which they could disclose to them about the most commonplace things which contribute to the enjoyment of Christmas. "How far that little candle throws its beam."

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BIOLOGY DIARIES FOR TRAINING IN OBSERVATION

One of the recognized objectives of biology teaching is training in accurate observation. While the instructor can plan his class and laboratory work to attain this objective, it is difficult to know how well the pupils are practicing the same principles outside.

In an attempt to extend this training into everyday life, and to aid the pupils in developing a leisure-time interest in science, the members of three biology classes were asked to keep diaries of their observations.

Each pupil was given a mimeographed sheet including sample entries from nature diaries and the following list of suggestions:

(1) Use a cheap notebook instead of a regular diary. Then you will have space to write as much or as little as you prefer.

(2) Write something every day if possible; and don't trust your memory too long.

(3) Be accurate. If you are not sure what kind of animal you saw, say so. If someone tells you there was an eagle down by the river, write in your diary that you *heard about it*, not that you saw it.

(4) If you need more information about something you have seen, look it up, or ask about it in class. But when you get help from a person or a book, admit it. If the information is correct, your helper deserves credit. If it is wrong, then you won't have to take quite all the blame.

(5) If you have trouble finding something to write about, ask questions. The following outline may give you ideas:

(a) Examples of biological principles: balance of nature; protective adaptations; cooperation of living things; etc.

(b) Effect of weather and change of season on living things.

(c) Identification of living things. (When you learn a new species, jot it down.)

(d) How plants and animals carry on the necessary life processes.

(e) Scientific discoveries, inventions, or principles which you read about.

(f) Examples of good scientific attitudes, or the opposite; examples of poor reasoning, superstitions, etc.

The day after the instruction sheets were passed out, a field trip was devoted to general observations intended to stimulate interest in the diaries. A week later in class, a few entries from Theodore Roosevelt's DIARIES OF BOYHOOD AND YOUTH were read aloud. After a period of one month the diaries were collected for grading. Although it seems unwise to emphasize grades on such outside work, pupils are anxious to know their rating; and grading is perhaps the most satisfactory way of telling them.

The diaries varied greatly, style and grammar ranging fróm pitiful to riotously funny. The observations were generally rather obvious, with little interpretation of their biological significance. Some were decidedly improved in subsequent work; and a few pupils wrote with enough insight that their diaries were really pleasant reading.

At the end of the second month pupils were allowed to substitute some other project for the diary. Some, by this time, had developed a more specialized interest. But the majority, perhaps because of mental inertia, continued with their diaries. During the last six weeks of the semester, when project work was entirely optional, eleven out of the seventy-two pupils continued their nature diaries.

If a few can learn to enjoy recording their observations, and the rest become slightly more aware of their environments, diaries are certainly worth trying.

TYPICAL ENTRIES FROM BIOLOGY DIARIES

September 26. I disturbed the balance of nature by cutting our lawn.

September 27. On my way home from school, I saw a large black ant carrying a dead one. I touched him with a leaf and he dropped his burden and ran.

October 24. This morning I saw two wasps on the sidewalk. They could crawl around, but couldn't fly. They crawled sort of lopsided too. I went on and in the next block, I saw another one just like the other two. That makes four I have seen that way.

November 10. On my way home, I saw many various objects which took my eye. I stopped to watch the tiny creatures I saw some squirrels storing up food for winter which shows how smart a little creature can be.

November 11. Coming home from town, I saw a deer, or something on a car. It was brownish gray and had big horns, or whatever you call them. He was dead and tied to the car. The car was from Missouri.

November 12. As I happened to be out walking through the park, they were cutting limbs from various trees and then painting the places where the operation took place to keep the trees from dying.

November 18. Flowers is something we very seldom eat, but califlower is an exception.

November 20. I saw a flock of small birds today. I do not know their name. They are small and have gray backs and white breasts. They fly in the weeds and when they go down by the ground, they sound like a rabbit is in the weeds. There was about 20 or 30 of them in one flock.

December 8. In the paper I read an article about Luminous Fish. It says the fish of the deep seas are able to produce light. They do not use the light to see but, to attract other fish. The scientists do not know the exact way the fish produce the light. They know it is partly produced by the food they eat.

December 14. I was watching a dog trot today and it looked to me as if he was running lopsided or something. It may have been just the way he was turned.

December 22. Today was our sixth snow, and the temperature has been about 20° all day long.

December 28. Today I saw a squirrel running across the grass. It went up a tree and around on the opposite side from which I was on. Squirrels always do that when someone comes after them. I think it is an excellent way of protection from hunters and other enemies.

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Books

MEIER, W. H. D., AND SHOEMAKER, LOIS MEIER. *Essentials of Biology.* Ginn and Company, Boston, 1938. 725 pp. $1.80.

Mechanical Make-up: Exhibiting an effective cover design of green, black and mustard the publishers present a revised edition of their 1931 text. The book measures 5¾ by 7⅞ inches, has a sharp black type and possesses a modicum of engravings, some of which lack distinction and sufficient didactic legends. There are two color plates on nature study executed by F. Schuyler Mathews. There is also a beautiful frontispiece in color by the same artist.

Literary Style: It can be said the understanding of the literary style of this book offers no difficulty to the average secondary school pupil. However, he is not likely to be attracted by it. The authors might have been oppressed by the voluminous size of our current secondary school texts and have omitted what might be termed "frills." It is still desirable to utilize a pleasant expository style rather than the academician's approach for the stimulation of further reading in the subject.

Subject Matter: Although the textbook is a revised edition it has not greatly changed from the original. There have been some important additions, but the book retains the character of texts that emphasize morphology rather than function. For the student in the rural districts it has a great deal of valuable material on the principles of plant culture, as well as a very fine chapter on plant diseases and their control.

Forty per cent of the textual material is devoted to morphology, 20% to physiology, 14% to economic biology, 10% to plant and animal breeding and evolution, less than 10% to health. Ecology is treated in connection with morphology. An excellent feature of the book is the story of the fine work of many famous biologists, with a "Who's Who" of biology.

Learning Exercises and Teacher Aids: The table of contents shows units that have both an interesting and practical point of view, but the actual text is encumbered by bits of information which the academic "bug" cannot relinquish. In place of some of the "organized knowledge," material devoted to motivation might have been of value. A short vocabulary of technical terms is found at the end of each chapter followed by a list of a small number of well-worded questions. In addition there are a few suggested problems for practical work by the students. Here one finds the approach is more for the specially interested biology student than for the student being introduced to the subject. The problems are well within the school library. The reference lists might be more extensive. The introduction of all new terms by italics is valuable, while a listing of the more important terms in the glossary further assists the teacher and the pupil.

Psychological Soundness: The organization throughout follows a strictly logical form. The book breaks up into Plants, Animals and Man. Indeed one unit is divided as follows: The Leaf, Stems, Roots, The Flower, The Fruit, and Seeds and Germination. One must select the proper chapters in order to obtain a seasonal approach. No psychological development is discernible. Some of the fundamental generalizations underlying biology and biology teaching receive little emphasis. Thus, there is little inductive or deductive

reasoning encouraged, and no provision is made for scientific method, one of the vital objectives of dynamic biology teaching.

Alan A. Nathans (*Chairman*)
Lloyd T. Carmichael (*Canada*)
Alfred Novak (*Illinois*)
Millard W. Bosworth (*Maine*)
Bernard Leibson (*New York*)
Mary I. Kerstetter (*New Jersey*)

Transeau, E. N., Sampson, H. C., and Tiffany, L. H. *Textbook of Botany.* Harper and Brothers Publishers, New York. xi + 812 pp. 1940. $4.00.

The authors of *Textbook of Botany* would be the first to discourage a purely laudatory review of their book, but there is little left for the reviewer to do. This volume is a product of master teachers who have spent many years in study and research leading to the improvement of instruction in general botany. The products of this effort, on the part of the authors, is clearly reflected in the pages of *Textbook of Botany.*

Textbook of Botany is truly a new book. The deviation from the conventional type of text is refreshing. Material from all the subdivisions of the botanical sciences is included; however, much more emphasis is placed upon the physiological, ecological and economic phases than is customary with the writers of most textbooks of general botany. The morphological approach has been subordinated to the foregoing principles, but it has in no way been relegated to an unimportant place. The morphological treatment is adequate for a basic understanding of plant processes. The dynamic or developmental rather than the static type of morphology is stressed. Eight chapters of the book are devoted to *Food of Plants, Food Manufacture,* and the *Use of Foods in Plants.* The water relations of plants receive ample emphasis. Four chapters are devoted to *Heredity, Hybrid Segregation, Mutations* and *Variations.* The chapter dealing with mutations is especially enlightening. A survey of the plant kingdom is given. Two chapters are devoted to the *Biology of Bacteria,* and *Bacteria of the Soil.* A discussion of the *Fungi,* especially those causing plant diseases is adequately given. The many fine illustrations of the *Algae* are welcomed. A comparative survey of the life cycles of the great groups of green plants is especially valuable in forming a foundation for the understanding of evolution of the plant kingdom. Twenty-six of the more common families of flowering plants are discussed from the standpoint of their characteristics, abundance, economic importance and distribution. The fifty or more pages devoted to the discussion and illustrations of the vegetation of North America, is unusual for a textbook of general botany, but nevertheless, a valuable feature.

Much of the material of this new book is based upon the research of the authors, both academic and educational. Many of the illustrations are original. Several color plates add to the value of the illustrations. This book will be doubly appreciated by those who think of the plant as a living, dynamic thing, rather than an aggregation of complex structures. The book is highly recommended to all those who may chance to read these pages.

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WESSEL, JOHN P., LEIGH, W. HENRY, and MEGLITSCH, PAUL. *Laboratory Text for General Zoology.* Chicago Planograph Corporation, Chicago, Ill., 1940. xiii + 285 pp. $2.25.

There are two schools of thought in the field of laboratory teaching. The one, originated by L. Agassiz emphasizes observation by the student, refusing to tell him anything that he can see for himself. This has been carried to extremes in some colleges where no laboratory outlines are used and the student is not only expected to use his own methods but to decide what he wants to study. At the other extreme stand those who say that Agassiz' system wastes the student's time, that he should be told exactly what to do and how to do it—even to the size of letters used in headings, and that if time and material run short it is just as well to copy a chart as to dissect the animal.

The authors of this laboratory text have struck a happy medium between these two extremes, though leaning toward the second school.

The attempt to integrate the subject by emphasizing the evolutionary concept gives a unity seldom seen in laboratory manuals. The review questions and particularly the charts showing the morphological and physiological features of the species in question should be of great value here.

The book is planographed on loose pages bound together with rings, an arrangement that would permit the insertion of extra sheets of drawing paper if desired. Many review questions are asked but spaces are not left to answer them, thus making it optional with the instructor.

Some pages are left blank for notes or required drawings: others have outlines to be filled in and several have complete drawings to be labelled, as the circulation of the frog. My own experience with this last item is that if given a drawing to label most students will label it without a look at their specimens. I regret too the omission of any green plant cell other than the Euglena. Mnium or Elodea leaves are much more typical than onion root.

One valuable feature of the book is its glossary and another, the list of Greek, Latin and Anglo-Saxon derivatives, shows that scientists are realizing, after years of neglect, that these languages have their value.

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(*Continued from page 91*)

fertile winter egg which, in the spring, develops into a wingless female. Non-fertile eggs give rise to a series of parthenogenetic forms until, finally, a winged form appears. This form lays two kinds of eggs, large female eggs and smaller male eggs. The sexual forms derived in this manner are wingless and, after fertilization, a single winter egg is formed.

It may be pointed out that an attempt has been made to read an interpretation of alternation into the development of vertebrates. In such attempts the vertebrate gastrula is compared to a transitional stage as well as a special organism adapted to the environment. If, however, the conventional concept of alternation is adhered to, the extension of the definition to this situation does not seem possible.

To attempt to set forth the interpretations placed upon the various aspects of alternation would be beyond the scope of this paper. A broad field of speculation has arisen. Whatever the justifications or outcomes of these speculations may be, the fact remains that the occurrence of alternation is far more common than was suspected when Chamisso generalized the concept in 1819.